Dynamic retention characteristics in RF driven long duration discharges on QUEST

K.Hanada[1)], N.Yoshida[1)], T.Honda[2)], A.Kuzmin[1)], H.Zushi[1)], I.Takagi[3)], A.Hatayama[4)], A.Fujisawa[1)], K.Nakamura[1)], H.Idei[1)], Y.Nagashima[1)], M.Hasegawa[1)], T.Onchi[1)], A.Higashijima[1)], S.Kawasaki[1)], H.Nakashima[1)], O. Watanabe[1)], O.Mitarai[5)], A.Fukuyama[3)], A.Ejiri[6)], and Y.Takase[6)]

1) Advanced Fusion Research Center, RIAM, Kyushu Univ., Japan.: 2) Interdisciplinary Graduate School of Engineering Sciences, Kyushu Univ., Japan.: 3) Graduate School of Engineering, Kyoto Univ.: 4) Faculty of Science and Technology, Keio Univ.: 5) School of Industrial Engineering, Tokai Univ.: 6) Graduate School of Frontier Science, University of Tokyo.

Long term tritium (T) retention in plasma facing materials (PFMs) is one of the most crucial issues and metal PFM is proposing for future fusion power plants. The ITER-like wall (ILW) project has been promoting in JET for the prediction of T retention in coming ITER D-T operation and significant reduction of long term deuterium (D) retention in ILW has been obtained [1]. Alternatively, short term (dynamic) retention plays an essential role in D circulation of the ILW [2] and it sometimes leads to be out of density control through excess in fuel supply due to fuel recycling.

QUEST is a distinguishing tokamak-type devices to provide a capability of long duration discharges [3] and, in fact, has already obtained good reproducibility of more than 5min non-inductive RF driven plasmas. Wall-released hydrogen (H) just after each discharge within 600 s is more than 70% of injected H, which shows dynamic retention is dominant in QUEST such as JET on ILW. Wall temperature (T_w) and influx of H to the PFM (Γ_{in}) give a significant effect in wall-retained H. So-called wall saturation, where no fueling is required to keep a target plasma density, was observed in several long duration discharges (LDD) with high T_w and few Γ_{in}, however much more H can store in lower T_w and higher Γ_{in} condition. Historical modification of PFM has been also investigated with postmortem analyses of plasma exposed specimens and it find that QUEST wall is covering by mixed material of 10~100nm in thickness (re-deposition layer). The QUEST-wall model [4] has been established based on the postmortem analyses and the model is applied to understand the characteristics of dynamic retention in the LDD. The model indicates that characteristics of dynamic retention on QUEST is expressed by a balance equation of in-out H flux into the re-deposition layer.

[1] V. Philipps *et al, Journal of Nuclear Materials 438 (2013) S1067–S1071.:* [2] S. Brezinsek *et al, Nuclear Fusion 53 (2013) 083023.:* [3] K.Hanada *et al, plasam science and technology, 13 (2011) 307.:* [4] K.Hanada *et al, Journal of Nuclear Materials, in Press*